Faculty of Resource Science and Technology

PREPARATION AND CHARACTERIZATION OF COMPOST FROM SAGO WASTE

NAWWAR MUNTAJ BINTI MOHAMED ASIF

(42635)

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NAWWAR MUNTAJ BINTI MOHAMED ASIF (42635)

This project paper is submitted in partial fulfillment of requirements the Degree of Bachelor of Science with honors

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(Name of the supervisor)

Dr Rafeah bt. Wahi
Senior Lectuter
Department of Chemistry
Faculty of Resource Science and Technology
UNIVERSITI MALAYSIA SARAWAK

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Dr Rafeah bt. Wahi
Senior Lecturer
Department of Chemistry
Faculty of Resource Science and Technology
UNIVERSITI MALAYSIA SARAWAK

Current Address:
IOT 18 TAMAN SEPANGGAR, JALAN SEPANGGAR, 88450 SEPANGGAR,
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LIST OF ABBREVIATIONS

AAS	Atomic Absorption Spectroscopy
DNA	Deoxyribonucleic Acid
SEM	Scanning Electron Microscope
C/N	Carbon/Nitrogen
G.I	Germination Index
HNO_3	Nitric Acid
HCL	Hydrochloric Acid
K	Potassium
Ca	Calcium
Mg	Magnesium
Ni	Nickel
Zn	Zinc
Mn	Manganese
Fe	Iron
Ca	Calcium
Cu	Copper
t	Tan

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ABSTRACT

A lot of sago is disposed off along the processing of sago palm. Unfortunately, the current process employed to dispose off sago waste is inefficient and often failed to remove the abundance of sago waste. Composting is proposed as an effective method for a variety of processing organic byproducts for application as soil conditioners and amendments. It is to improve the soil fertility to produce a good quality plants and improve its stability and maturity. The preparation of compost was done by a mixture of sago waste, chicken manure and woodchips in a ratio 1:1:1. After 2 months of composting, the color was dark brown, earthy smell with a constant temperature of 29°C. Compost indicates it contain sufficient moisture content and total organic matter which available for microbial growth. Total N:P:K present in compost with a ratio 0.96:0.39:0.68 results that soil contain a good nutrient content which are not toxicity towards plant yet they can grow well in a sufficient amount of nutrient to water spinach and green mustard.

Key words: Sago waste, sago palm, chicken manure, composting, woodchips.

ABSTRAK

Banyak sagu dilupuskan sepanjang pemprosesan pokok sagu. Malangnya, proses semasa digunakan untuk melupuskan sisa sagu adalah tidak cekap dan sering gagal untuk menghapuskan lebihan sagu. Kompos adalah dicadangkan sebagai satu kaedah yang berkesan untuk pelbagai pemprosesan hasil sampingan organik sebagai perapi tanah dan pindaan untuk meningkatkan kesuburan tanah yang menghasilkan tumbuh-tumbuhan berkualiti dan meningkatkan kestabilan dan tempoh matang yang cukup. Penyediaan kompos telah dilakukan oleh campuran hampas sagu, tahi ayam dan serpihan kayu dalam nisbah 1:1:1. Selepas 2 bulan kompos, warna kompos bertukar coklat gelap, bau tanah yang subur dengan suhu malar 29°C. Kompos juga menunjukkan ia mengandungi kandungan kelembapan yang mencukupi dan jumlah bahan organik yang disediakan untuk pertumbuhan mikrob. Jumlah N: P: K hadir dalam kompos dengan nisbah 0.96: 0.39: 0.68 menunjukkan bahawa, tanah mengandungi kandungan nutrien yang baik yang tidak ketoksikan terhadap tumbuhan namun mereka dapat tumbuh dengan baik dalam jumlah nutrien yang mencukupi ke atas kangkung dan sawi hijau.

Kata kunci: hampas sagu, pohon Sagu, tahi ayam, kompos, serpihan kayu.

1. INTRODUCTION

1.1 Background of Study

Sago palm came from the palmae family of the genus *Metroxylon. Metroxylon* sago is used by over million people as a dietary starch source. This extremely important sago generally the most important economic over Malaysia as it is imported commercially in Indonesia, Philippines and New Guinea as sago starch and they also used as a fuel ethanol or food production (Wang et al.,1996).

The effluent of sago waste produced by the sago palm creates a large pollution which causes a serious effect of pollution to the environment results inefficient solid waste management. This is due to the excess amount of liquid and suspended solid residue throw off to the river which is largely composed of lignin and cellulose. According to Quek et al.,(1998), lignin and cellulose from sago waste has a high potential of bio absorbent component to cause a polluted environment. With a high humidity and starch content, sago waste is difficult to be handling (Awg-Adeni et al., 2010).

The presence of lignocelluloses material causes sago waste act as a cohesive pollutant with no significant industrial application rather than an animal feed supplement and chipboard production (Rong et al., 2013). However, the presence of lignocellulosic material has a great potential for fermentation for laccasse production through solid substrate fermentation. In addition, the preparation of activated carbon is useful as a biosorbent for the removal of metal ions such as lead and copper that embedded in sago waste. These consider sago palm well recognized and its potential is essential (Singhal et al., 2008). Table 1.1 shows the composition of sago waste.

Table 1.1: The composition of sago waste (Singal et al., 2008).

Component	Percentage %
Starch	65.7
Crude fiber	14.8
Crude protein	1.0
Fat	n.d
Ash	4.1
Moisture	5.91

Fine sago waste is the residue from the sago palm after starch extraction. According to Chew and Shim (1993), Sibu and Mukah in Sarawak produced 50-110 t fine sago waste every day which hold 66% starch and 14% fibre on a dry weight basis of which 25% is made of lignin. The left sago has been used for feedstuff, manufacture or even compost in mushroom culture and soils (Phang et al., 2000).

A good alternative for utilizing agriculture waste like sago waste is by converting it to compost. Compost is a control decomposition of organic material that can be dug into soil as well to improve soil structure or nutrient quantity in order to be use as useful products (Irshad et al., 2013). Other than its role as an environmental friendly, compost is the best ways for waste disposal which enables recycling of organic matter. As an acceptable method for waste treatment, previous research had proved that compost can help in reducing space as well as giving the nutrient needed for the plant (Lima et al., 2004). In industry, one of the applications which are based on 100% sago waste husk is the production of binder less boards. This binder less board is used in industry of manufacturing building and packaging materials (Ann et al., 1998).

1.2 Problem Statement

Sarawak is the largest producer of sago flour and a lot of sago waste is disposed off along the processing. Unfortunately, the current process currently employed to extract the abundance of sago waste is inefficient and failed to remove residual starch embedded in the fibrous portion of the trunk. Approximately, 7t of sago waste is produced and yet they are mixed together with wastewater causing another environmental problem. Several studies on the utilization of sago waste as substrates for local microbes or even particleboard manufacture have been done by researches but it shows low productivity to solve sago waste problem. Sago palm generates a huge amount of waste products such as chopped trunks, dead fronds, shells and fibers. Either they discharged into the waterways or incinerated, these over abundance of sago waste is actually contribute to the environmental problems results in a nutrient imbalances, toxic elements and phytotoxicity in crops (Awg-Adeni et al., 2010).

Sago waste is the main problems to bigger factories produced massive quantities are too tough to be handling yet this waste is difficult as it is not easily dried due to its high moisture and starch contents (Sriroth et al., 1999). Thus, to solve the crisis, composting is an effective method for a variety of processing organic byproducts for application as soil conditioners and amendments. This will improve the soil fertility into a useful product to produce a good quality plants and improve its stability and maturity.

1.3 Objectives

The objectives of this study are to:

1. Prepare compost from sago waste as a nutrient improvement of soil and nutrient quantity.
2. Characterize the affect of the parameters towards the compost which is must be controlled.
3. Study the germination and growth of plants during compost.

2. LITERATURE REVIEW

2.1 Sago Palm

Sago palm is commonly found in tropical lowland forests and freshwater swamps. Sarawak is the largest producer of sago palm mostly located at Mukah which covered 75% planting area. The measurement of sago palm is about 10-12 um high and a diameter about 0.8- 1 m. the palm is planted using young suckers and develops more suckers before reaching maturity after 9- 11 years which takes a very long period for the plant to be harvestable (Flach, 1997).

Sago palm produced huge starch production where starch is the main carbohydrate source in Malaysia. Compared to other starches, sago has low cost of production and have high yield (Fasihuddin et al., 1996). That is why sago is the best option as the starch source for tropical countries and the world's highest starch producer are at 25t/ha/year. According to Ishizaki (1997), sago gives a highest starch produce among all starch crops of the world which are rice (6t), corn (5.5t), wheat (5t), potato (2.5t).

Virtually, sago palm has its own major local use in Malaysia though it was extremely hardy plant, growing more slowly in peat soil than mineral soil. The study of Flach (1996) stated that, the bark of the sago palm is used as the flooring or in case people are suffering in flood, these bark helps as the swampy area and used as firing in factory. Besides that, ground pith is also used as the animal food especially for the chicken, horses and pigs in farm. The house construction virtually uses the leaves of sago as the roof hatch and wall siding comes in many ways get produce such as bags, cages, baskets and rope as well (Awg- Adeni *et al.,* 2010).

2.2 Sago Waste

Sago waste primarily consist a part of lignin and cellulose which contribute most to the water pollution in Malaysia's agriculture. These fibrous residue left behind after all starch has been extracted out of the sago palm (Awg-Adeni et al., 2010). Due to the presence of lignocelluloses material, this huge pollutant can't be use except as an animal feed and production. Meanwhile, the use of dried fibrous ago waste has been found to be used as a good fertilizer for a compost. Starch residue mainly the large producer of sago waste, are the huge causes especially to the bigger factories. They are not easily dried yet they are very difficult due to its high moisture and starch content (Awg-Adeni et al., 2010). Other part is fine sago waste. It is generated from pith of *Metroxylon* sagu (sago palm) after starch extraction process. Fine sago waste contains 66% starch and 14% lignin fibre on a dry weight basis. These fine sago waste certainly can be used as a compost.

Furthermore, fine sago waste has a great potential as a bio adsorbent to remove any heavy metal contamination in water polluted. It is found that, they are having higher initial sorption rate and greater sorption capacity. It was reported that fine sago waste is potentially to be effective and economically useful adsorbent (Kadirvelu et al., 2004). The abundance sago waste may be utilized for the production of fermentable sugars where the glucose from the sago starch is used as substrate (Singhal et al., 2008). As year passed, the production of lactic acid from the sago waste has attracted researcher to its use as a raw material for the synthesis of polylactic acid, a biodegradable plastic materials. The production of kojic acid also gives much attention due to its economical potential in the field of medicine, food science and agriculture (Gomes et al., 2001).

2.3 Composting

Compost is the process of organic waste being decompose such as crop residue or animal mature to actively fertilize as it contain a good nutrient. However, organic matter is fundamental in maintaining the soil fertility of a nutrient even though the compost is actually the chemical fertilizer contained in organic matter. By the end of season, chemical fertilizer is to be breakdown into nutrients in order to save the plants to be use of. Whereas the organic matter remain to increase soil fertility, soil structure, and water storage capacity (Madeleine *et al.*, 2005).The use of bacteria involved in composting are also become one of a factor of solid waste. The new methodology to detect the presence the bacteria along with the characterization in composting are very important especially pathogens.

Currently, the development of DNA probe method and phenotypic technique precisely is to identify the genus and species level of bacteria in order to compost various waste (Curiale, 1990). For instance, indigenous microorganisms are to complete the stable product of biochemical transformation. As similar to compost, microbial can change the chemistry of organic waste. The presence of microbe utilized carbon as a source of energy and nutrient to build protein energy. This is one of a factor compost can grow faster as they also excrete plant nutrient such as phosphorus and nitrogen (Nirmala et al., 2013). In the decomposition process, there is the combination of materials such as manures, animal waste, straw, green waste that are digested by naturally. This material is digested naturally in the microbes that available to plants for use as nutrient sources. The process of compost decomposition relies on the right combination of carbon and also nitrogen, right moisture and the ability to blend and aerate the materials.

2.4 Composting of Biomass/ Agriculture Waste

Biomass in palm oil industries had huge resources currently in Malaysia. They contribute 85.5% of the more 70 million tons of biomass (Shuit, Tan, & Kamaruddin, 2009). Palm oil generate huge amount of waste such as chopped trunks, dead fronds, empty fruit bunches, shells and fibers. Biomass comprises natural compounds such as cellulose, lignin and proteins and many kinds of biomass have high moisture content because the origin of biomass is living organisms. One of the most important and large residues left behind after most sago starch left out is well known as fine sago waste. If we apply the waste directly to the plants, the composition of sago waste might contain heavy metals, pathogenic microorganisms, bad odors which results a bad damage to the plants and environment. Fine sago waste discloses a large number of starch granules to be trapped within the lignocellulosic matrix (Chew & Shim, 1993). The amount it released depends on the quality of the extraction process. According to Eneji et al (2001), composting process however have gained a wide acceptances as organic amendments for sustainable agriculture as they have been shown to increase soil organic matter as well enhancing microbial biomass, activity and diversity as source of food and energy (Chefetz et al., 1998).

2.5 Key factors in Composting Process

The composting process is going easy if it taking a carefully-precaution-step to obtain a perfect compost. Therefore, they need a well condition to live. These are the important key factor of composting process:

2.5.1 Aeration

Aeration is very important to determine the presence of oxygen. Oxygen is the most concern to detect the growth of microorganisms. Aeration can also be affected with the moisture, wind and porosity. In order to maintain the stability of compost, composting reduces the pile's porosity and decreases the air circulation. Also, aeration can be improved by aerate the pile continuously with a shovel. It will increase its porosity. Another option is too add coarse materials such as leaves, straw or corn stalks (Chen et al., 2011)

2.5.2 Moisture factor

Decomposition process needs water to live. Microbial activity occurs faster in water film on the surface of organic materials. Optimum moisture of composting should be 40 to 60 percent. During composting the moisture must be maintained always to allow the bacteria doesn't come. If there is more than 60 percent, water will go up smothering the bacteria which leads to unpleasant odor (Chen et al., 2011)

2.5.3 Oxygen factor

Composting can occur in both aerobic and anaerobic conditions. However aerobic composting is more suitable composting as it can survive at O_2 concentration as low 5%. During composting, the microbial activity increase in the compost pile so they used a lot O_2 for energy (Chen et al., 2011).

2.5.4 Temperature factor

Temperatures determine the rate of biological process. High temperatures characterize the aerobic composting. Pathogens are normally destroyed at 55°C and above. Turnings and aeration can be used to regulate temperatures (Natural Resources Management and Environment Department, 2003). A way to monitoring temperature is to stick fist into the pile. It is fine if the pile is felt hot or warm. If vise versa, then the composting needs to add a nitrogen and turning the pile (Chen et al., 2011)

2.6 Characterization of compost

2.6.1 Physical characterization

2.6.1.1 pH

pH is very important to determine the acidity and alkalinity of compost. Maintaining the pH of compost is vital as applying the soil may alter the soil pH. A normal pH measurement for compost is within 6.5 to 8 ranges because the low acidification, the microbes will active as it related to an anaerobic condition inside the compost (Prasad et al., 2013).

2.6.1.2 Temperature

Temperature is important to the growth rate of compost and metabolic activity of the organism. Temperature is recorded using mercury thermometer. Temperature also determines the rate of decomposition that take place in composting pile (USEPA, 1994). USEPA (1994) state that, the most effective composting temperature is between 45 and 59 °C. If temperature is larger than 59°C, it can eliminate a pathogen. Obviously the composting does not get a successful composting. The other way, if temperature is 45°C it has a potential of greater drying, dry weight loss and oxygen consumption (Wiese et al., 1998).

2.6.1.3 Dry Matter and Moisture Condition

Moisture is always maintained at 40-60 % throughout the experiment. Moisture condition is to measure the quantity of water content in a compost process. It was assumed to contain 50% moisture, if it disaggregated slowly on release. But if it as 40% moisture it was considered to be too moist (Iris et al., 2012).

2.6.1.4 Scanning Electron Microscope (SEM)

SEM bombards a specimen with a beam of electrons instead of light. It produces a highly magnified image from 100x to 100,0000x magnification. SEM with energy dispersive spectroscopy (EDS) is used as an imaging and micro analytical tool in characterization of fibers of compost and raw sago waste. Surface morphology can be examined with great depth of field at continually variable magnifications (Kale et al., 2006).

2.7.2 Chemical Characterization

2.7.2.1 Nitrogen Content

Nitrogen can synthesizes protein and build cells and reproduce it. Nitrogen is part of amino acids and nucleic acid need for plant production (USEPA, 1994). Study of Herity (2003) state that, the amount of total nitrogen and plant available nitrogen is depends on the composition of waste and composting process. 1 % less dry weight can be used too as a soil conditioner to compost.